DOCUMENT RESUME

ED 241 254 SE 041 790

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TITLE "Help Wanted, Inquire Within": Estimation. Activities and Thoughts That Emphasize Dealing Sensibly with Numbers through the Processes of Estimation. (Grades 1-6). Title I Elementary Mathematics Program.
INSTITUTION Des Moines Public Schools, Iowa.
PUB DATE 79
NOTE 25p.
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Addition; *Computation; Division; Elementary Education; *Elementary School Mathematics; *Estimation (Mathematics); Guidelines; Learning Activities; Mathematical Concepts; Mathematics Instruction; Measurement; *Metric System; Multiplication; *Problem Solving; Subtraction; Units of Study
IDENTIFIERS Elementary Secondary Education Title I; PF Project; *Quantitative Thinking

ABSTRACT

Developed for elementary teachers, this activity unit is designed to teach students the importance of estimation in developing quantitative thinking. Nine ways in which estimation is useful to students are listed, and five general guidelines are offered to the teacher for planning estimation activities. Specific guidelines are provided for teaching estimation in the following areas: quantity; rounding; addition; subtraction; money; multiplication; division; measurement (including spatial relationship, body measurement, and linear measurement); volume; temperature; time; and mass. The five main activities offered are (1) guessing the number of objects on a piece of wallpaper; (2) weighing rocks; (3) measuring the length of wallpaper, including metric measurement; (4) measuring shoe string licorice using a metric ruler; and (5) estimating the number of chews in a Tootsie Roll, the number of sips in a glass of Kool-Aid, and the amount of time it takes to melt peppermint candy. Eight additional short activities are offered at the end of this unit. Also included is a list of the sources used to develop this unit. (EM)

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Activities that emphasize the importance of estimation to develop quantitative thinking.

DES MOINES INDEPENDENT SCHOOL DISTRICT

1800 Grand Avenue

Des Moines, Iowa 50307

"Help Wanted, Inquire Within"

ESTIMATION

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Activities and thoughts that emphasize dealing sensibly with numbers through the processes of estimation. (Grades 1 - 6)

Title 1 Elementary Mathematics Program

1979

Estimation, as presented in elementary math textbooks, is usually limited to a few pages that tie-in with the four basic processes. The ideas and applications are suitable but do not extend far enough. The premise of this collection of ideas is that estimation has a far greater usability than just those few seemingly isolated pages. Estimation in the classroom should happen everyday as it does in real life.

Estimating helps children with:

(1) Problem solving both before and after actual answer is found

(2) Motivation

(3) Open-ended type problems

(4) Understanding some important concepts

(5) Understanding the size of numbers and dealing sensibly with numbers

(6) Developing quantitative thinking

(7) Providing a quick check on reasonableness of a calculated answer

(8) Developing a positive attitude toward mathematics

(9) Competing only with themselves to improve the accuracy of their estimates.

Guidelines to plan estimation activities:

(1) Explain as soon as possible that there are no specific rules to follow in making many types of estimates. This will help children feel secure.

(2) Keep activities simple and sequenced allowing children to be successful.

(3) Encourage children to count, measure and sometimes calculate to get feedback on certain types of estimates.

(4) Encourage children to focus on improving the accuracy of their estimates rather than competing with others to "get the right answer".

(5) Satisfy the children's need for variety by giving them experiences with all types of estimation and by using puzzles, games, contests and calculators to make estimation "come alive".

ESTIMATION

I. Quantity

A. Child can look at piles of blocks to develop the concept of more and less. 1 - 1 correspondence can be used to check it. The need for checking increases as the groups of objects become more equal.

B. Make an estimate of a larger collection such as marbles or beans in a jar. Devise a way to check.

1. Counting by 1's if the set is small.

2. Sorting the objects by 10's or 100's.

3. Count part of the objects into a measure. Then count the number of measures it takes to empty the jar. This will provide only an approximation of the quantity.

4. Sorting by child's own system.

Children should be encouraged to be creative in their approach to estimating a quantity and in developing ways to check their estimates.

C. Have children assemble a set of objects to approximate a certain quantity, eg. knowing that a package of paper contains 500 sheets, select 100 pieces, or knowing that there are approximately 100 Tootsie Rolls in a sack, select 43.

This procedure is the inverse of A and B.

How Many

Materials Needed:

Wallpaper sample book - each piece of wallpaper used should have a number of objects on it that is within the familiar range of the students.

Type of Group:

Individual, small group or whole class

Object:

Make the best guess as to how many objects are on the piece of wallpaper.

Procedure:

Show the paper enough time for a reasonable guess to be made but not long enough for the students to count the objects. After all have made a guess, count the objects or establish a reasonable approximation together.

Younger children may need help in organizing their counting. If the pattern of objects is regular in any way, addition or multiplication may help in the counting. If the pattern of objects seems to be random but fairly evenly spaced and the number of objects is large, then you could count them by dividing the sheet into sections and counting the objects in one section and multiplying that number by the number of sections. Or, if the design is small enough you might find the repeat pattern to assist in approximating. Unless the guesses are very close, an approximate answer will be sufficient.

Once counting techniques have been introduced, small groups of students can do own sheet.

Variation:

Begin with the question about a smaller part of the sheet then extend it to the whole sheet. For example, use a sheet of paper with about fifteen flowers, each has approximately the same number of petals. First ask, "How many petals are on a flower?" Have the student estimate and check. Then ask the children about how many petals are on the entire sheet. This encourages the student to break the problem into smaller parts when they are estimating.

Adapted from:

Let's Do It - Wallpaper Caper by Mary Montgomery Lindquist and Arithmetic Teacher, February, 1979 - Marcia E. Dana

II. Rounding

A. An introduction to the skill of rounding might include the use of non-standard units of measurement. Using straws, for example, a child might measure a table and discover that it measures between six and seven straws. The idea of which is closer should be used. This can be extended to the use of rulers perhaps with 1" or 1 cm markings.

B. Rounding to the nearest 10 would follow from the previous activity. The use of a partial numberline would perhaps be helpful. In rounding 37:

Extend this idea to the rounding of numbers to the nearest 100, 1000, and 10,000 as appropriate.

C. Money activities can provide meaningful rounding experiences. It is useful to round to the nearest dime, dollar, or quarter. Consumers are confronted with many situations where a knowledge of rounding numbers is very helpful - even essential.

III. Addition and Subtraction

A. In working with basic facts if the child knows that 3 + 3 = 6 then it can be estimated that 3 + 5 is more than 6.

B. In working addition and subtraction problems at all levels of difficulty, the estimation of the answer would help a child to determine if the answer is likely to be correct. Too often, children learn the processes of arithmetic with little or no insight into what they've done. Rounding numbers is necessary to make the estimation.

68	70	93	90
+23	+20	-37	-40
	90		50

732	730	700
+413	+410	+400

Children who become skillful at rounding numbers can use their skill to make quick adjustments to their estimations, depending on how much they "rounded off".

C. Money activities would be appropriate at this time.

(1) Totalling grocery items by rounding is a relevant activity. This would provide practice in rounding to the nearest dime or dollar. Sometimes, it is useful to round to the nearest quarter.

(2) Rounding can be used to determine what can be bought for a certain amount of money. Catalogs or newspaper ads could implement this activity.

(3) Given a set of objects with attached prices, form a collection of objects whose total would be within a certain range.

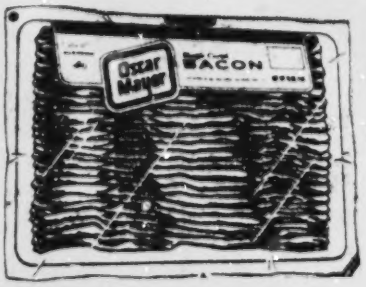
(4) Estimation can be helpful in making change.

D. Map activities using estimation would involve the rounding numbers for population and distances. Knowing distances can lead to the estimation of travel time, gallons of gas, total cost of trip, and miles per gallon.

$.54

$1.39

$.79



$1.79

$1.79

$4.19

$.43

Rounding to 10's

$	.50
	1.40
	.80
	1.80
	1.80
	.40
	4.20
$	10.90

Rounding to quarters

$	.50
	1.25
	.75
	1.75
	1.75
	.50
	4.25
$	10.75

IV. Multiplication

A. In working with the basic facts, if the child knows that 4 x 8 = 32 then, if asked is 4 x 6 more or less than 32 the child will say that 6 is less than 8 therefore, 4 x 6 is less than 4 x 8.

B. The development of the algorithm for multiplication by 10, multiples of 10, and powers of 10 is basic. A model could be used to illustrate a simpler progression.

2 x 3	2 x 6 - 6
2 x 3 tens	2 x30 = 60
2 x 3 hundredths	2 x300= 600

Another approach could include the regular multiplication problem wherein the child would see the placement of zeros and derive a shortcut.

$$\begin{array}{r} 35 \\ \times 20 \\ \hline 00 \\ 700 \\ \hline 700 \end{array}$$

67	70	7 tens
x34	x30	x3 tens

C. The estimation of products is valuable as a way to check the validity of work.

9 x 62	9 x 60 = 540
65 x 303	70 x 300 = 21,000
147 x 384	100 x 400 = 4,000

D. Division

Rounding the dividend and/or the divisor will help the child make an estimation to the division problem. Then estimation will also be valuable as a way to check the validity of work. Basic knowledge of the division algorithm is also important.

$$6\overline{)375} \qquad 6\overline{).400} \quad \begin{array}{r} 60 \\ 360 \end{array}$$

$$37\overline{)982} \qquad 40\overline{)1000} \quad \begin{array}{r} 20 \\ 800 \end{array}$$

$$63\overline{)3421} \qquad 60\overline{)3400} \quad \begin{array}{r} 50 \\ 3000 \end{array}$$

$$67\overline{)500} \qquad 70\overline{)500} \quad \begin{array}{r} 7 \\ 498 \end{array}$$

V. Measurement

A. Spatial relationship. Children can compare heights, lengths, weights, etc. of various objects based upon a visual or tactile estimate eg. comparing heights of children, lengths of tables, etc.

B. Body measurements, for example, are helpful in estimating such as hand spans, footsteps, finger widths, etc. Knowing the approximate measure of your footstep can be useful in estimating the size of a garden. Keep in mind that as children grow, the body measures will need to be revised.

C. Linear measurement. In order to become adept at estimating with linear units of measurement, it is necessary to become very familiar with the size of units through direct measurement. Once a mental image has been established, estimating can begin. The procedure should be to:

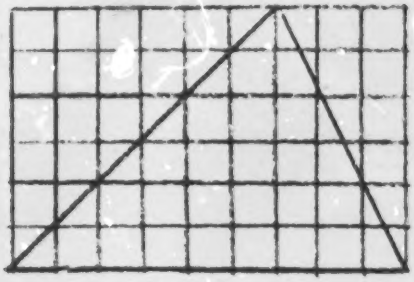
1. estimate
2. record
3. measure
4. record
5. compare.

By using this procedure for each item to be measured, it should be possible to refine the accuracy of each successive estimation. This is an ideal way to become familiar with metric units - to learn by doing.

1. Estimate lengths or widths of various objects. Compare with the actual measurement.
2. Using a straight edge, draw a line a specified length. Measure to see how close you are.
3. Find an object that has a certain length.
4. Find four objects with the sum of the lengths equalling 3 meters.

Perimeter would be a logical extension for estimation of lengths. This, in turn, would lead into the idea of area. For children who are not familiar with the formula for area, it would be more useful to estimate an area by comparing to a model of a square unit of measurement.

Tiling would be another way to estimate area, especiallly if the shape is irregular. Grid paper could be used as well.



D. Volume. Skill in estimating the capacity of container should be developed through direct measurement. In his article, George Bright suggests using grocery sacks for the computation of volume because the sack can be easily filled and measured with objects of the same size. Jars with various shapes can be misleading if the child cannot conserve volume. Jars of the same size, however, could be ordered by volume.

E. Temperature. The development of the idea of temperature needs to be done on a daily basis. By making an estimate and comparing with the actual temperature, a person can learn to make more accurate guesses.

F. Time. Durations of time can be very elusive - sometimes the time just zeros by and sometimes it really drags - so when asked to determine the length of a minute, it is sometimes difficult to do. Try it. With a group of two or more, close your eyes. Raise your hand when you think a minute is over. Have the other person let you how close you were.

Given a minute, how many times can you write your name, how many math problems can you do, etc.

G. Mass. Familiarity with the units of measurement is once again important. It is critical that the objects be lifted in the same manner as objects lifted close to the body will seem lighter than those lifted away from the body.

1. Order a set of objects according to their mass. Check the accuracy of estimation.

2. Estimate the mass of an object. Compare with the actual weight.

3. Using clay, make a ball that has a certain mass.

4. If you know the weight of one object, sort several other objects into categories such as 10-20 g., 20-30 g., etc.

VI. Activities

A. Rocking with Math

Materials needed: rock for each student, scale a weight for weighing rocks, paper and pencil.

Type of Groups: Whole class and individual

Object: To estimate the weight of a rock. To order rocks from largest to smallest. To find something in the classroom the same weight as the rock. To find the total weight of all of the students' rocks.

Procedure: Have each student bring a rock to class. The rocks can be any type of rock which the students choose.

Have each child estimate the weight of his/her rock. The metric system (grams) or the English system (ounces) can be used for the unit of measure. This estimate should be recorded, then the student should weigh the rock.

Have the students place the rocks in order from smallest to largest. Ask "Is the larger rock always the heavier? Why? Why not?" Have the students put the rocks in order according to weight - lightest to heaviest.

Have the students find something in their classroom that is the same weight as their rock. How did they find the object? Did they estimate first and then weigh it?

Have the students find the total weight of all the rocks.

Adapted from Gary Grimm and Don Mitchell, Good Apple Math Book, Good Apple, 1978.

B. How Long?

Materials Needed: Wallpaper sample book - sheets of wallpaper used should have several obvious lengths to measure, metric ruler, paper and pencils.

Type of Group: Students work with a partner.

Object: To be closest to the actual length of object measured. To earn the most points.

Procedure: Teacher or students mark about ten different lengths on a piece of wallpaper and label the lengths with letters A, B, C ... Each student estimates the length of A, then after each has done so they measure it. The student whose estimate is closer receives a point. Knowing the length of A can often help a student make a better estimate for the length of B. The student with the most points after all estimates and measuring is the winner.

Variation: A more challenging game for older students would use curved lines or open or closed figures. A piece of string can help in measuring curved lines. Or, if a piece of wallpaper contains many rectangles the students could estimate the areas.

Adapted from Mary Montgomery Lindquist and Marcia E. Dana, "Let's Do It" from Arithmetic Teacher, NCTM, February, 1979.

C. Shoe String Licorice Measuring

Materials Needed. Shoe string licorice, metric ruler, paper and pencil.

Type of Group: Individuals, small groups, or whole class.

Object: To estimate measurements as close to actual measurement as possible. To estimate by observation several lengths in proper order (from shortest to longest).

Procedure: Give each student a shoe string of licorice.

1. "Can you bite off exactly 6 cm?" Have the students measure the piece bitten off.

2. Have each student cut their licorice into 5 equal pieces. Estimate the length of each piece, then measure the length.

3. Looking at all of the pieces (whole ones) of licorice, who has the longest shoe string? Estimate its length. Measure it. Can the students estimate the order of the shoe strings from longest to shortest. Compare them to find the correct order.

4. If the student eats 12 centimeters of the shoe string, estimate the length of the licorice left. Measure it.

5. If the student bites off 8 centimeters at a time, estimate how many pieces of licorice will the student get? Then do the activity.

6. Have each student estimate the number of pieces of shoe string licorice it will take to equal 1 meter. Do the activity.

Adapted from Gary Grimm and Don Mitchell, Good Apple Math Book, Good Apple, 1976.

9. Sweet Averages

Materials Needed: Tootsie Rolls, peppermint candies (round or stick), cups and Kool-Aid.

Type of Group: Individuals, small group, or whole class.

Object: To estimate the the number of chews of a Tootsie Roll, the number of sips of Kool-Aid, the time it takes to melt a peppermint candy. To estimate the small group average for each. To estimate the whole class average for each.

Procedure: First, students should learn how to find averages.

Have the class divide into small groups of 4 or 5 students each.
Give each student a peppermint candy with the following instructions: "You are to record the time it takes to melt the candy, to do this, record the starting time (the time the candy goes into your mouth) and the ending time (when the candy is all gone). Find the difference of the two times for the melting time. Have the students find the average for the small group and the average for the whole class (small group averages together).

Have a pitcher of Kool-Aid made and enough cups for each student. Give the following instructions: "You are to estimate the number of sips it will take you to drink all of the Kool-Aid in the cup. Record this estimate. Drink the Kool-Aid, counting the number of sips to finish the drink. Record. Estimate the small group average. Record. Find the average for the small group. Record. Estimate the average for the whole class. Record. Find the average for the whole class. Record."

Have enough Tootsie Rolls so that there is one for each student. Give instructions similar to the proceeding ones, but this time the students estimate and count the number of chews to eat a Tootsie Roll.

Some questions to ask at the end of the activity:

1. Was there a large difference in the individual responses to each part of the activity? What could have caused these differences (chewing the candy instead of melting it, large or small sips, letting the Tootsie Roll melt instead of chewing.)

Activity	Type	Estimate	Actual
Peppermint candy	Individual		
	Small group average		
	whole class average		
Kool-Aid	Individual		
	Small group average		
	Whole class average		
Tootsie Rolls	Individual		
	Small group average		
	Whole class average		

Adapted from Gary Grimm and Don Mitchell, Good Apple Math Book, Good Apple, 1976.

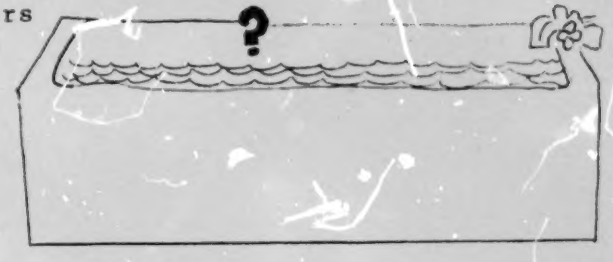
E. Miscellaneous Activities

each dime has a mass of 2 grams

1. What do you think a bag of dimes would be worth that has the same mass as you do?

   (a) less than $100
   (b) between $100 and $500
   (c) between $500 and $1000
   (d) between $1000 and $5000
   (e) more than $5000

2. If you take baths in a normal size bathtub, about how many liters of water do you use in 1 year? Does a shower use more?



3. Make a quick estimate and circle the correct ending.

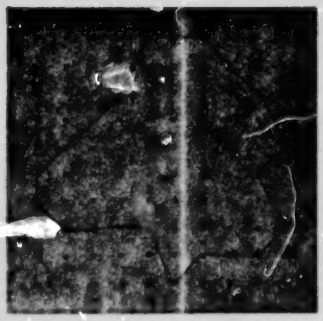
   DON"T FIND THE EXACT ANSWER!

(a)	35 + 8 is	over 40	under 40
(b)	54 - 6 is	more than 50	less than 50
(c)	43 + 49 is	more than 80	less than 80
(d)	67 + 13 is	more than 77	less than 77

4.

Start with	153
Subtract 17	-17
	136
Subtract 17	-17
	119

Guess how many 17's you must subtract to reach 0. Try it! How many 17's in 153?

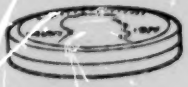


5. There are 100 nails on the geoboard. Estimate visually (without counting) the number of nails enclosed by the rubber band.

   How close was your estimate? Try several of these with a partner.

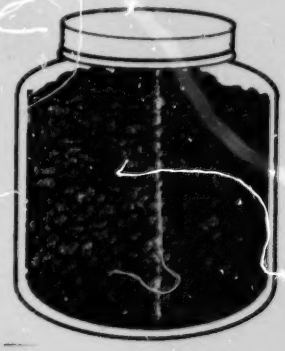
6. Estimate how many pennies are needed to make a stack of pennies so high as a penny standing on edge!

   (a) less than 8
   (b) 8
   (c) 9
   (d) 10
   (e) more than 10



7. Can you estimate the number of beans in the jar?

   Best guess wins a PRIZE!



8. The centimeter unit (cm) is about the width of the fingernail on your pointer finger. Estimate the length of these objects using this unit.

   (a) your shoe
   (b) your eraser
   (c) your desk
   (d) your finger

*From O'Doffer, Phares, "A Case and Techniques for Estimation: Estimation Experiences in Elementary School Mathematics - Essential, Not Extra;", from Arithmetic Teacher, NCTM, February, 1979.

These thoughts and ideas for activities are only a sampling of the possibilities. If you consider the many times each day that you use estimation, this will provide you with more ideas to implement. Chances are, however, that estimation is such a common occurrence, that you may not realize how often you use it. A little imagination and common sense will go a long way in creating experiences. Children will develop confidence in their abilities to estimate if they are provided with a systematic idea of instructions. They need to learn that an exact answer is not always necessary.

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